Building a Safer Industry

Construction is a risky occupation—on a daily basis, construction workers face environmental exposures to many dangerous materials and practices. Drillers, sandblasters, drywall sanders, and brick masons risk inhaling particles of dust, sand, and crystalline silica, which can lead to lung cancers, tuberculosis, and silicosis. Welders and other metalworkers risk inhaling metal fumes, which can cause lung ailments, airway disorders, and cancer. Asphalt used in paving and roofing has been linked to throat irritation, nausea, and chronic lower respiratory infections. Workers doing finishing work can breathe in toxic fumes from paints, adhesives, floor finishes, and other materials. And renovation and demolition of old buildings exposes workers to lead paint, asbestos, and toxic molds.

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Over the past decade, however, the building industry has been taking aim at environmental hazards for workers. The results have spawned a new generation of safer materials and better safety training and practices to decrease risks and safeguard worker health.

Along with changes within the industry, outside forces are also helping to shape the landscape. For instance, a growing number of consumers are demanding that builders and developers use environmentally friendlier and safer materials. Architects are increasingly taking into account the human health impacts of building materials. Numerous government agencies have specified the purchase of "green" building materials, thus encouraging an expanding market for these products. Regulatory agencies, manufacturers, and nonprofit organizations have established standards and guidelines for hazardous emissions from building materials. And efforts to improve worker education in environmental health are increasing. The result is that many construction workers are handling fewer toxic materials, and homeowners and office workers are better able to live and work in healthier environments.

Hard Hat Areas

It can be difficult to tease out the effects of specific building materials and practices on human health because of possible confounding factors such as multiple toxic exposures, worker lifestyle factors, previous illnesses, and chemical sensitivities that can exacerbate tendencies toward occupational illness. Respiratory diseases can occur due to interactions among workplace hazard exposures and other factors such as nutrition, exposure to chemicals through hobbies, cigarette smoking, and illnesses

such as gastroesophageal reflux disease and viral infections. Workers who smoke, for example, have a 10 times higher risk of developing lung cancer from asbestos exposure than workers who do not smoke, according to *Asbestos in Construction*, a hazard alert published by The Center to Protect Workers' Rights, a research and education program of the AFL-CIO based in Silver Spring, Maryland.

Unusual sensitivities to chemical or hazardous materials also contribute to occupational illnesses. Some researchers argue that a long-term, low-level exposure to a hazardous substance, or a large one-time dose, can turn the biological switch that activates chemical sensitivity. "When you look at the range of the human population, there may be up to a tenfold difference in chemical sensitivity," says Kaye H. Kilburn, a physician specializing in environmental medicine and occupational health at the University of Southern California Keck School of Medicine in Los Angeles. "A one hundredfold or one thousandfold or ten thousandfold increase in chemical sensitivity from the normal range says that something has happened to make this person hypersensitive. There are hundreds of people running around with chemical sensitivity who were perfectly normal before an indoor air exposure or exposure to a dose of chemical," she says.

Still, there are many known effects from specific exposures that the construction labor force, homeowners, and residents near construction sites face. And it is in reducing these effects in particular that efforts are being directed.

Volatile organic compounds (VOCs). VOCs are organic chemicals that become a breathable vapor or gas at room temperature. VOCs such as formaldehyde, benzene, ethylene glycol, and vinyl chloride are commonly used in building materials including solvents, binding agents, and cleaning agents. Managing VOCs remains one of the most important considerations in controlling indoor air pollution and health effects for installers and occupants of new construction.

Perils of painting. Breathing paint fumes containing toxic VOCs can lead to a host of illnesses, but new paints are lowering or eliminating these components.

For many years, high-VOC paint was the industry standard. Heavy amounts of VOC solvents were added to paint to enhance color and spreadability, and also to function as fungicides and biocides. But VOCs "off-gas" during the application and curing of paint, and even after the paint is dry. These emissions can cause headaches, respiratory problems, and allergic reactions.

It is difficult to determine the average level of worker exposure and a specific "unsafe" VOC dose for two reasons. First, VOCs in paint can react in the air and with other chemical coatings to create new compounds with health effects that are not fully known. Also, VOCs can be harvested from natural or synthetic sources, and the health effects can vary widely, depending on the VOC source.

Perhaps the easiest way to control VOCs is by using environmentally friendly paint. Since the mid-1990s, most manufacturers of brand-name paints have significantly reduced VOCs in some of their product lines. These "low-emitting" paints reduce the quantity of indoor air contaminants that are irritating or dangerous for installers and occupants. Products that are labeled zero- or low-VOC must meet U.S. Environmental Protection Agency (EPA) standards for VOC levels; manufacturers can also meet a voluntary Green Seal Standard for still lower VOC levels.

The difference in the standards results from how different organizations classify VOCs. The EPA's classification system is based on smog control and, as such, leaves out many chemicals in paints, such as acetone and methyl acetate, that may be dangerous to inhale but that do not fit the agency's VOC definition. However, while some solvents may not be on the EPA's list of VOCs, they still may end up on the EPA's list of hazardous air pollutants that require stringent reporting. Green Seal is an independent, nonprofit organization based in Washington, D.C., that identifies and promotes environmentally safer and less-polluting products by affixing a "Green Seal" protected by federal copyright law. Their standards are often more stringent than those set by the federal government. For example, the EPA VOC standards for flat and nonflat interior paints are 250 g/L and 380 g/L, respectively. In contrast, the Green Seal standards are 50 g/L and 150 g/L.

Environmentally friendly paint may have practical or aesthetic limitations, however. Low- or zero-VOC paints are generally limited to colors such as white, beige, and pastels. "Anytime you had colorant, you add chemicals," says Gail Lindsey, an architect based in Wake Forest, North Carolina, and a consultant on green building principles for federal agencies. "The amount of colorant you put in is connected to the VOC level."

"Materials in general are becoming safer to the user," says Alex Wilson, executive editor of *Environmental Building News*. "There's been a big shift away from the solvent-based, high-VOC materials to

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acrylic- and water-based products that are lower in VOCs and tend to be less noxious. The old complaint that newer products aren't as good and don't last as long is largely not true, either. The quality has improved tremendously."

For decades, formaldehyde has been an almost ubiquitous VOC used in building materials. Manufacturers add formaldehyde, which is relatively inexpensive, as an ingredient to help bind wood chips and sawdust together. There are two kinds of formaldehyde-based binder used in building products. Urea formaldehyde is used to manufacture pressed-wood products such as particle board in subflooring and shelving, hardwood plywood paneling in decorative wall covering and cabinets, and medium-density fiberboard in cabinets and furniture tops. Urea formaldehyde, which is a nonwaterproof binder, generally emits higher levels of VOCs than does phenol formaldehyde, which is a waterproof binder used in exterior-grade plywood and house framing.

Crystalline killers. Silica crystals inhaled during sandblasting can cause severe long-term effects. A push is on to require use of respirators to prevent such inhalation.

Individuals exposed to formaldehyde can suffer brain impairment, leading to symptoms such as prolonged reaction time, abnormal balance and clumsiness, short-term memory problems, and elevated anger and confusion levels, says Kilburn. Exposure to formaldehyde in human studies is linked to a rise in lung cancer and nasopharyngeal cancers, according to the EPA. The rate at which formaldehyde is released is accelerated by higher temperatures and higher humidity.

In recent years, manufacturers have generally lowered formaldehyde levels in their building products. Changes have been driven partly by government standards but also by nonprofit trade groups.

In the 1970s and 1980s, there was concern about formaldehyde emissions from particle board and hardwood plywood bonded with waterproof resins. These concerns led to regulations that restricted the amount of formaldehyde that could be emitted from a product. Since 1985, the U.S. Department of Housing and Urban Development has had a standard for formaldehyde emissions in manufactured housing of less than 0.2 ppm for plywood and 0.3 ppm for particle board. Many products are stamped to indicate compliance with these standards, which are designed to maintain an ambient level of 0.4 ppm or less in manufactured housing. The National Indoor Environmental Institute, the American Society of Heating, Refrigeration, and Air-Conditioning Engineers, and the American National Standards Institute recommend a limit of 0.1 ppm for indoor levels.

Other manufacturers have designed new products containing formaldehyde "scavengers," specific ureas that bind to formaldehyde and prevent it from volatilizing. Even so, there continue to be emissions from both waterproof and nonwaterproof binder products.

Asphalt fumes. Asphalt is a solid or semi-solid material made from distilled crude oil that is used primarily in paving, roofing, and asphalt-based roof paints. Over 350,000 U.S. workers are exposed to asphalt at paving sites, hot-mix asphalt facilities, and roofing and manufacturing sites.

Asphalt fumes are responsible for a host of health ailments including nausea, stomach pain, decreased appetite, headache, fatigue, and skin, eye, nose, and throat irritation, according to a December 2000 National Institute for Occupational Safety and Health (NIOSH) hazard review titled *Health Effects of Occupational Exposure to Asphalt*. There is substantial evidence that links acute lower respiratory tract symptoms to asphalt fume exposure, and more research is being done to clarify the rela-

Unfriendly fumes. Asphalt gives off toxic fumes, but new guidelines are focused on lessening the opportunity for exposure.

Top to bottom: EPA; Arnold Greenwell/EHP

tionship, according to the review. Researchers also recommend additional studies on possible links between asphalt exposure and several chronic diseases, including lung cancer.

Some safety measures recommended by the hazard review include using personal protective equipment to prevent skin exposure, maintaining the lowest possible asphalt temperature for application, and using appropriate respiratory protection. In response to the NIOSH report, William A. Good, executive vice president of the National Roofing Contractors Association, recommended in a 6 February 2001 letter to association members that they consider using kettles with engineering controls and keeping them in open areas far from building air intakes, using low-fuming asphalt, monitoring heating temperatures, and using insulated pipes.

Before the December 2000 NIOSH report, several manufacturers including Blaw-Knox, Caterpillar/Barber-Greene, Cedarapids, Roadtec, and Champion collaborated with NIOSH and several union and labor health organizations to develop draft guidelines used by contractors and manufacturers of large hot-mix asphalt pavers. This led to exhaust control guidelines for highway-class hot-mix asphalt pavers. The guidelines stress the importance of proper ventilation systems for paving machinery, certification of paver performance, and adequate worker training for the operation and repair of paver exhaust ventilation systems.

Silica. Crystalline silica is a mineral from the earth's crust found in sand, flint, agate, quartz, and other materials. Silica inhalation, even with low-level, unprotected exposures, can cause adverse health effects including silicosis—scarring and hardening of lung tissue that prevents oxygen from entering the blood. During sandblasting of buildings and other similar activities, silica is broken up into very fine particles. Without proper protective gear, workers can inhale silica particles less than 5 microns in diameter into their lungs. Larger particles may be inhaled into the nose or throat and can be swallowed. Silicosis is generally a result of prolonged exposure, but symptoms may not appear until 5–10 years after exposure.

NIOSH recommends that workers use no sand or abrasive containing more than 1% silica, and the agency requires that workers use NIOSH-approved respirators, provide outside air sources, and perform air sampling during projects.

Metal fumes. When metalworkers weld at very high temperatures, vaporized metal can cool quickly and form a fine particulate fume made up of tiny solid particles less than one micron in diameter. Due to their small size, fumes are able to penetrate deep into the respiratory system to the alveoli. Safety experts are concerned about the presence of certain toxic metals including chromium, nickel, cadmium, zinc, and copper in the fumes.

Of particular concern is the chromium compound called hexavalent chromium. It is used as pigment in paints, inks, and plastics, as an anticorrosion agent in protective coatings, and in chrome plating. Workers can be exposed to hexavalent chromium when welding or cutting chromium-containing metals such as stainless steel. Hexavalent chromium is recognized as a potential human carcinogen, although there is limited evidence in humans and inadequate evidence in experimental animals for the carcinogencity of chromium compounds in welding fumes, according to NIOSH.

Welders' woes. Welding metals releases a number of toxic fumes that can be avoided with the use of proper ventilation systems.

Inhaling such fumes also can lead to ailments such as metal fume fever, which causes symptoms similar to those of a very bad case of the flu. Workers are at risk for metal fume fever when heating stainless steel and zinc. Fumes inhaled from cadmium alloys, coatings, and silver soldering can cause chemical pneumonia, a condition that can prove fatal if not treated quickly.

Under Occupational Safety and Health Administration (OSHA) rules, mechanical ventilation must be provided when welding or cutting is done in small spaces or where the welding space has structural barriers that interfere with cross-ventilation. For outdoor stainless steel welding or cutting, approved respirators must be worn. But workers also must have access to information about the substances they are welding. "You need to have local exhaust ventilation right at the source, and workers need to have material safety data sheets on welding materials to know whether the materials contain cadmium or other hazardous substances," says Michael McCann, director of safety and ergonomics for The Center to Protect Workers' Rights.

Issuing respirators alone may not prove effective because many workers take them off for the sake of convenience. "In the past, workers using respirators to protect against nickel and manganese might run out of air, then pull the mask off to finish the job rather than get another air tank," says Kilburn. A number of ventilation strategies are therefore recommended to help protect metalworkers from dangerous fumes. Ventilation that pulls fumes away from welders' faces can reduce the risk, particularly for those who do not use respirators all the time.

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Scary sealants. New research shows that chromated copper arsenate, used to treat wood for decks and other construction, can leach into skin and be inhaled.

Chromated copper arsenate (CCA)–treated wood. Federal regulators are studying the health risks of using wood preserved with CCA to construct decks, playground equipment, docks, fence posts, and other structures. People who touch or rub CCA-treated wood can absorb small amounts of arsenic through the skin. Very young children can ingest much higher levels of arsenic when they put their hands in their mouths after playing on CCA-treated playground equipment. Homeowners and laborers cutting CCA-treated wood can inhale arsenic in dust, resulting in speech and central nervous system impairment that may be irreversible.

Wood was the major ingredient in 136 million tons of building-related construction and demolition debris in 1996, according to a 1998 EPA study, *Characterization of Building-Related Construction and Demolition Debris in the United States.* At least 500 wood processing facilities in the United States receive wood supplies from construction and demolition sources, according to this study. It is currently difficult to distinguish untreated wood from CCA-treated wood in construction and demolition debris, so consumers who buy mulch or wood chips made from recycled construction wood can be exposed to potentially hazardous doses of CCA, as well as enhance dispersal of the chemical by spreading contaminated mulch in their yards.

Helena Solo-Gabriele, an environmental engineer at the University of Miami, and colleague Timothy Townsend of the University of Florida in Gainesville are investigating ways to distinguish CCA-treated construction waste. One possibility is spraying the wood with a chemical stain that will change color if it comes into contact with CCA. Consumers and workers can protect themselves by using gloves when handling CCA-treated wood. When using power tools, workers and consumers should use respirators to avoid inhaling CCA in dust created during sawing or drilling.

The EPA has initiated a risk assessment of CCA. During this assessment, the EPA will examine all uses of CCA, including the potential risk to children who play on structures built with CCA-treated wood. The agency is expected to make available for public comment the preliminary risk assessment during spring 2002.

In 2001, manufacturers committed to begin an information program to help consumers identify CCA-treated wood and its hazards. Manufacturers agreed to attach information tags on each piece of treated wood and provide information through store displays, a Web site, and a toll-free number.

Lead. Lead paint was used for more than a century for both interior and exterior surfaces. Painters and other tradesmen in proximity to lead paint can suffer effects from lead including loss of appetite, nausea, vomiting, fatigue, moodiness, and joint or muscle aches. Severe health problems include damage to the central nervous system resulting in tremors, seizures, convulsions, and wrist or foot drop, in which muscle or nerve damage causes deformities of those parts of the body. Acute lead poisoning can be fatal.

Renovation and demolition projects on old buildings can be particularly dangerous to workers and homeowners as lead is more likely to be present in older construction materials. Lead paint was also commonly used on steel girders to protect them from the corrosive effects of weather. Using torches during maintenance and repair work can vaporize lead.

Ventilation and tenting procedures can contain poisonous fumes, thereby protecting repairers and passersby. NIOSH lead safety procedures include wearing personal protective equipment such as respirators, showering and changing clothes before leaving the work site, and periodic testing of air and blood concentrations.

Asbestos. Between 1940 and 1979, an estimated 27 million people in the United States experienced occupational exposure to asbestos, according to an August 2001 report by the RAND Institute for Civil

Unsafe to solder. Exposure to lead during soldering without protective gear can lead to a number of neurologic effects and even death. Most at risk may be workers engaged in renovations of older buildings.

Top to bottom: PhotoDisc; PhotoDisc

Costly cleanup. Workers removing asbestos from buildings must protect against inhaling the cancer-causing fibers.

Justice titled *Asbestos Litigation in the U.S.: A New Look at an Old Issue*. Asbestos was used as an insulating and fire-prevention material. Structures built in the United States after 1980 were prohibited from containing asbestos, but the presence and removal of this hazardous substance is still creating major health problems.

Breathing asbestos fibers can cause asbestosis and scarring of the lungs, which create difficulty in breathing. Exposure to asbestos is also linked to mesothelioma, a cancer of the chest and stomach lining, and increased risk of lung cancer, according to *Asbestos in Construction*.

Nothing revealed the lingering dangers of asbestos so plainly as the aftermath of the September 11 terrorist attack on New York's World Trade Center towers. Asbestos was used for fireproofing during construction of the north tower and was never removed. The collapse of the north tower dispersed asbestos in a huge cloud of dust. During the cleanup, workers have risked asbestos inhalation each time they have dislodged rubble or carted away pulverized materials.

In the United States and around the world, workers will continue to experience the health consequences of asbestos installed decades ago. By 1999, asbestos use was prohibited in much of the world, yet 30 years after peak asbestos exposure levels (determined by adding together the quantity of asbestos produced and imported per capita during the 1970s, then subtracting asbestos exports for those years), 30,000 citizens from Western Europe, North America, Japan, and Australia are diagnosed with asbestos-related cancers each year, according to Antti Tossavainen of the Finnish Institute of Occupational Health.

Moreover, many nations in the developing world continue to use asbestos in construction, guaranteeing a rise in certain cancers and other illnesses decades hence. At the 11th Annual Congress of the European Respiratory Society in September 2001, Tossavainen noted that worldwide asbestos production topped 2 million tons in the year 2000. The Russian Federation produced 700,000 tons, China produced 450,000 tons, and Canada produced 335,000 tons, exporting almost all of it.

In the United States, OSHA requires protections for asbestos-abatement workers including full-body protective gear and bans on eating, smoking, and drinking in areas where asbestos may be present.

Molds. An emerging concern is the presence of irritating and toxic molds in buildings. High levels of mold exposure can cause a variety of symptoms, including allergic reactions. Certain molds can also exacerbate respiratory problems. The molds in building structures that are receiving the most attention include certain species of *Aspergillus*, *Penicillium*, and *Stachybotrys*.

Mold and moisture problems in buildings have many causes, including uncontrolled humidity, inadequate ventilation, roof leaks, and gutters that direct water under buildings. A major factor in the recent surge in mold growth is the use of paper-faced gypsum wallboard, an ideal cellulose food source for molds. Molds can also grow on the surface of damp glass, metal, and concrete if the substance is coated with organic material.

A. fumigatus causes the illness aspergillosis, which can lead to pulmonary infection, allergic bronchopulmonary disease, and death, if not treated promptly. The toxic by-products of the fungus *S. chartarum* (formerly known as *S. atra*) have been linked to an outbreak of infant illnesses and deaths due to bleeding in the lungs [see *EHP* 106:A11–A12 (1998) and 108:A20–A23 (2000)]. Researchers found large volumes of *S. chartarum* in the homes of the infants who had died, although other factors such as exposure to tobacco smoke may have contributed to the lung bleeding. Some medical experts believe this fungus can cause serious health problems in adults as well.

Informed designers and builders now use techniques to minimize the potential for building moisture. Mold remediation involves identifying and fixing underlying problems, then drying and decontaminating or removing damaged materials, a sometimes costly and difficult process, depending on the extent of contamination. The EPA recommends that, at a minimum, workers removing molds wear eye protection, gloves, a respirator, and disposable overalls.

Hidden harm. Toxic molds can grow in materials such as gypsum wallboard and cause allergic reactions if inhaled during drilling or other construction activities.

Top to bottom: U.S. Army Corps of Engineers, Mobile District Visual Information; PhotoDisc

Constructing Solutions

Over the past 20 years, the building industry has increasingly recognized that improved training and education are essential to protecting workers from dangerous materials and practices. "If you're trained and know how to do your job and if you follow the rules, then construction is pretty much as safe as any other job," says Andrew Port, project manager for environmental health and safety at the Whitman Companies, an environmental engineering and management firm in East Brunswick, New Jersey. "But if you cut corners, you can get in trouble. That's why education is so important to explain the risks and hazards and ways that workers can protect themselves."

Nevertheless, workers in some construction sectors may actually have less access to apprenticeships and safety training than they once did. That's because fewer workers today belong to unions than they did 20 years ago, according to McCann. An estimated 70% of U.S. construction workers belonged to labor unions in the 1970s, but that participation shrank to approximately 20% of the construction workforce in the 1990s.

Meanwhile, though, OSHA education and training programs have significantly improved safety training, especially for large construction companies. But a continuing problem, some believe, is that high-quality training can be expensive, especially for small companies. This may be overcome, though, by making use of government-sponsored training, counters H. Berrien Zettler, the OSHA deputy director for the directorate of construction.

In fiscal year 2001, OSHA budgeted approximately $67 million in training and education for U.S. workers. "For the large or small contractor, education cost is not a significant barrier because OSHA does not charge a lot," says Zettler. Many training materials are available for free on the World Wide Web, he says. Construction firms can also receive low-cost safety training upon request when they contact a local area OSHA office. In addition, OSHA has established a consultation program for the small-business employer in each state. The program is conducted by a state agency but receives 90% of its funding from the federal government.

Another part of the problem is the reluctance of some contractors to send their workers to training courses. "The training resources are available to contractors if they could overcome their hesitation about sending employees or even supervisors to the courses," says Zettler. "The obstacle is that some small businesses on the financial margins consider any time away from the job site, even for safety training, to be unproductive time."

For fiscal years 1997–2001, OSHA received special congressional appropriations to offer safety training to residential construction contractors, trade union employees engaged in residential construction, and OSHA compliance officers. But OSHA faces still other roadblocks in offering these programs to some construction sectors. Many small construction firms, particularly those involved in residential building, can be difficult for OSHA to locate. The residential building industry is highly fragmented, and most home builders are small-businessmen who construct fewer than a dozen homes a year. "The most obvious challenge is knowing where these people are," says Zettler. "There's no one central information source for locating construction employees. If they are working on a large housing project, we can easily find them. But if they are building individual houses on individual lots, which is a major part of the residential construction industry, they are very hard to find." Many residential contractors employ different workers from project to project, and may only hire when they have work to do. Residential contractors are also the ones most likely to employ lesser-trained workers and employees who do not speak English as a first language.

"The problem of locating workers for safety training is even worse for renovation, because there's not a consistent permit system throughout the country," says Zettler. Big cities such as Washington, D.C., usually have well-established permitting systems for renovations, but many rural areas lack permitting requirements of any kind.

LEEDing the Charge

A growing number of developers, building owners, government agencies, manufacturers, and architects are embracing special rating systems that help the building industry select environmentally friendly building materials and processes for entire structures. The most prominent rating system is the Leadership in Energy and Environmental Design (LEED) standard created by the U.S. Green Building Council, a nonprofit coalition of architects, construction companies, engineers, product manufacturers, and others. "The LEED system has created a lot more interest in new products and technologies as well as in analysis of buildings," says Wilson. "It's created interest among mainstream companies that may never have paid attention before."

Through performance standards, LEED sets up objective, measurable criteria for the "greenness" of buildings. Developers and building owners can voluntarily have their structures certified as "green" by reducing water consumption, using passive cooling or solar heating technologies, providing for alternative transportation, using low-emission materials, or making a host of other changes. Applicants can apply for basic LEED certification or accumulate extra points to reach silver, gold, or platinum LEED status. Building owners who attain LEED certification can qualify for some state and local tax credits and other incentives. Because LEED ratings are based upon building design and renovation, not long-term use, ratings are in effect for just five years. Then buildings must undergo an operations-and-maintenance rating for LEED status to be retained.

In establishing standards for certification, the LEED system has borrowed from regulations and guidelines set by various government agencies and nonprofit organizations. For instance, in establishing the LEED's VOC emission standards, the Green Building Council referenced adhesive and sealant limits established by two California air quality agencies, paint and coating standards formulated by Green Seal, and a carpet testing procedure from the Carpet and Rug Institute of Dalton, Georgia.

Some states, localities, and federal agencies have encouraged green construction by implementing policies that call for their own buildings to meet certain environmentally friendly standards. Seattle, Washington, has gone perhaps the furthest, requiring that all new public buildings in the city be built to at least a silver level of LEED certification. The General Services Administration (GSA), which provides space, goods, and services for the federal government, influences the management of more than 8,300 government-owned buildings or leased buildings. GSA is working to earn LEED ratings for all of its new and renovated buildings. Eleven GSA projects have been registered to attempt certification.

Governments spend billions each year on new and renovated buildings, so this is a powerful market for green building products. Many large architectural and engineering firms, which have contracts to build or renovate environmentally friendly government buildings, are taking this expertise to private-sector clients, who are showing an increased interest in green construction. By requiring innovations in public agencies, governments are spawning greater acceptance of environmentally friendly building products and techniques in the private sector, which should lead to both a safer and healthier building industry and safer and healthier buildings.

John Tibbetts